

The two other specimens on the table (one cut, the other "in the rough"), are also from Gipps Land, and certainly from the district of Donnelly's Creek. There is a large piece, but very foul, in Mr. M. Stephens' fine collection, found in the Jim Crow Ranges.

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ART. IV.—*The Volcanic Rocks of Rome and Victoria compared.* By JAMES BONWICK, ESQ., F.R.G.S.

[Read 12th March, 1866.]

Having visited above thirty volcanoes in Victoria, to the westward, as well as some in South Australia, I was naturally led, when at Home, to look at the volcanic districts of Europe. I had the pleasure of inspecting those of Auvergne, Naples, and Rome; besides, at the suggestion of Sir Roderick Murchison, having a ramble amidst the singular geology of the German Eifel. My state of health, at the time, did not permit of much walking, and so hindered my researches.

In the present paper I would omit all reference to Vesuvius, where I saw the flow of lava and *felt* a shower of ash, and would confine my observations to the singular parallel existing between the volcanic formations of our western country in Victoria, and that of Rome and its neighbourhood.

Rome, Eternal Rome, has indeed a charm to civilized man. So absorbing was its interest to me, that I was never more in Dreamland than there. I wonder now that the geological found a place in my mind. And if any weakness or error of description appear in my narrative, I must make this the ground of my apology to the Society.

What a history could one atom of Roman dust unfold! In the early ages hurled out of the caverned fire,—trodden by wild races without memorial or name,—entering the sturdy oak or cropped in grass by lowing oxen,—a fertilizer of the glowing Campagna,—a portion of the human frame—perchance of Cæsar,—and then a lowly dust again; how like the tale told of Rome itself!

In some respects, the budding maiden of Victoria, whose blushing beauties are yet unknown to Europe, presents a striking likeness to the long-revered and well-beloved matron of the Seven Hills.

In comparing the Tufa, or Volcanic Ash of the two places,

it may be stated, that both have the *tufa lithoide*, or consolidated stone ash. It is more abundant on the Roman than on the Victorian soil. As a building-stone with both, it has been employed in the most massive and important erections of Italy, and but little in this colony. Piles of it were reared in the Coliseum, and even used in the more ancient Cloaca. Climate and age seem to have no effect upon it. Here I have seen it in church ornaments at Belfast and Warrnambool. Saints' heads, effigies of sovereigns, dragons, and other primeval personages, inclusive of a volcanic John Wesley reposing on a monster at the Belfast chapel, have all been sculptured out of the Merri Creek tufa. I have seen some chimney-tops, and even substantial walls of stone, of the same material. A little skill is required in its manipulation. The strata being horizontal, and not so consistent as the Italian, should not be set up on the edge. A publican, near Mount Shadwell, had faced his house with this easily worked stone; but having set it up perpendicularly, flakes have been so constantly falling that soon the various leaves will have flown out.

The Roman *tufa lithoide* is reddish brown in colour, with much pumice. Most of the Seven Hills contain it. The best quarry, however, is on the road to Albano, about nine miles from Rome. The Mamertine prisons, in which Paul and Peter are said to have been confined, are cut out of this rock. I found St. Elmo dungeons to be excavations in the Naples tufa. This ancient formation is a *Peperino*, being, as it were, peppered over. That used in the sewer, or *cloaca*, is a sort called *gabina*. The Tarpeian rock is very hard and red lithoide. The source of this tufa is not very apparent, and not, probably, in any of the existing craters. Sir R. I. Murchison has supposed that vents discharging ashes may have closed so as not to be distinguished now.

The more recent beds of tufa were, doubtless, thrown down from the existing craters upon the dry land, and are horizontal in position. The fresher ash contains hardly a trace of pumice, and is of a lighter colour. The *lapilli*, or small cinders, are in both sorts. Sand-shells and land-plants have been found in the newer sort. That north of the Campagna is whiter and contains pumice. The Peperino of Albano has fossil wood occasionally in it.

The *Pozzolano* of Rome is a particular sort of tufa, found in the ash-beds in small quantities, and highly prized for cements; with the addition of a little lime it forms a good

material for submarine structures. I have examined the *Trass* of the Brohl Valley, near the Rhine, which has the same property. As we have not yet utilized our colonial tufa, I am not able to say how far we may produce a Victorian cement from that source.

As the *Pozzolano* was anciently called *Arena*, and obtained from the vast masses of tufa around Rome, some have erroneously supposed the catacombs to have been *arenariae*, or sand-pits. I did not perceive any material difference between the ash of the catacombs and that of Victoria. Excavations could readily be made in our own, as the wom-bats discover; and as the material will not hold water, it would not be objectionable for a cemetery. The Italians term the catacomb-stone *tufa granolare*. It is like ours, to use the words of Daubeny, "dull and harsh to the feel, with an earthy fracture." It appears not to be so rich in minerals as the Peperino of Albano, which contains the garnet, nepheline, mica, Vesuvianite, and dolomitic limestone. Dr. Curdie assured me he had detected much Vesuvianite in his ash-banks by the Curdies river, towards Cape Otway. The eruption occurring in a limestone country would account for the nodules of that rock found in the Roman tufa. I saw much of it in the ash of Mount Gambier, the neighbourhood of which is all limestone, and whose craters are hollows in that rock, blown out or subsiding during the convulsion.

Excavation in the tufa would afford admirable shelter. The shepherds of Italy, to this day, find relief from weather on the Campagna in the grottoes dug out in the ash. The ancient Etruscans used such for tombs. The Roman tufa-beds afforded graves before the Christian era, even to the Jewish colony of that city, though the catacombs became eventually the honoured and revered property of persecuted Christendom. As I stood in one of the dimly-lighted recesses, with my hand idly mingling the dust of martyred loved ones with the ashes belched from a roaring crater, and listened to a lecture by an Irish priest upon the recovery of the bones of St. Cæcilia, beside whose grave we were gathered, and whose anniversary of martyrdom was then being honoured, I could not but feel how rich with sacred and loving association was the tufa of Rome compared with ours.

There is a sort called *Pisolitic Tuff*, or Tufa. This has balls, or shot-like pieces, supposed to have been produced by drops of rain at the time of the fall. The calca-

reous ash, so common in Albano, is equally plentiful with us.

There is a great extent of territory covered with ash in the old Roman States. The sea-board of the Campagna beds extends ninety miles, while the breadth from hills to coast is about twenty-five. The Campagna in Rome, though a plain, is not without many undulations. The soil is very fertile. Once sparkling with a hundred cities, it is now almost a desert. Neglected culture has left undrained marshes to breed the dreaded malaria, which now reaches the walls of Rome. Let us hope that better days will see the tufa-fields of Rome covered with good farms and a healthy people.

The ash on the Victorian plains is darker than that of the Campagna, and more generally of the granolare than the lithoide character. Around the extinct craters, and on the plains at their feet, the formation reposes. To the south and west of Lake Corangamite and Lake Colac, many such spots may be seen; and so, also, passing from Ballarat to Portland, or Portland to Warrnambool. Excepting a few places, as Mount Franklin, little tufa is found upon our diggings. The later convulsions southward and westward have arisen, doubtless, since the auriferous period. Tower Hill, between Belfast and Warrnambool, shows the largest extent of this singular mineral, affording the finest farming land in the colony. A paddock of fifty acres of Mount Gambier ash soil has this year averaged fifty bushels of wheat to the acre.

The depth of the ash of Rome is considerable, and even greater than that which covered up Pompeii. In our colony it has been frequently found one hundred feet. At Woodford I observed great masses. It is ninety feet near Timboon. By Tower Hill, the bank is thickest on the eastern side, owing to the prevailing westerly breezes carrying the ash away. On the north side, a farmer, a quarter of a mile from the crater, told me it was eighty feet. Another, a mile off on the eastern side, sank one hundred and fifty feet in it for water, and gave up the work. Around Mount Gambier, the tufa varies greatly. In one part I saw it at least two hundred feet thick, but found it run out on the north side in a quarter of a mile. On another side, at an equal distance, it was forty feet. The Ash Peak rises hundreds of feet high. On the Pejark Marsh, between Mount Noorat and Lake Keilambete, it is evenly distributed. The tufa of Lake

Colongulac rests on the basalt. It was in clay thereon that the remains of the great marsupial lion were discovered. Black cindery sand is on the hard tufa of Lake Petrobe of Warrnambool. A red clay divides the ash of Woodford from the dark basalt beneath. The Moorabool tufa may have been thrown from the volcanic hills of Pentland, above Bacchus Marsh. The best ash-bed I saw westward was in a crater twelve hundred feet in diameter, eight miles from Mount Porndon, which the squatter had converted into a wonderful vineyard and garden.

But I may be pardoned some extracts from an account I wrote at the time of a visit to the ash-banks of our Tower Hill Volcano, as such a description found interest with the British Association in 1861, and as it truly depicts what I saw also in the banks of the Roman Crater of Lake Albano :

“Tower Hill Lake is seven miles round. The outlet is on the south-western side. On the east south-east side, where a quarry has been attempted to get stone for the church, the volcanic rocks were of great interest. Beneath the soil was a layer of small cinders, some assuming the appearance of calcareous, hard cement of white ashes. This rested on a dark blue flinty, splintery basalt, of a most unworkable character, traversed by singular seams of lime, and running down, as it were, not only under but beside the white ashes, and also by a bed of black, cindery conglomerate, not adhering, but like a loose mass of small cinders. Under the dark ashes I detected the layers of the common brown ash-stone or tufa, dipping thirty degrees west. Near the flinty basalt was a bed of argillaceous finger-staining earth, in association with a clinker-like cinder. The calcareous ash seemed everywhere running in white veins, through all other rocks. Curiously enough there were nodules of cherty limestone, which must have been pieces of the original limestone crater wall.

“Limestone rises, and a limestone quarry, are apparent on the western side of the hill, the tufa still lying on the lower lands immediately beside the limestone hills, which in one place were tilted twenty degrees to the west.

“A gem of a crater is seen on the eastern side of the Trigonometrical hill (inside of the lake). No grass was growing upon its fire-blasted walls. The rock was of compact basalt, green basalt, clinker, cinder, mammeloidal, convoluted, laminated, &c. There was one perpendicular block of cinder, thirty feet in height, possessing some remarkable aspects of volcanic agency.”

*Volcanic conglomerate* is another product of the Roman hills. The circumstance under which we find it would lead us to suppose that it was much more abundant formerly, and that great masses have been washed off their old sites. A hill of this conglomerate of fine ash and cinders exists near Lake Bracciano, surmounted by a mediæval castle. The famous citadel of Tusculum, not far from Albano, was erected upon a rock of this substance, which itself stands on a stream of lava. There is a variety of this rock, much consolidated and studded with garnets, which is called by the Italians *Sperone*, the *lapis Tusculanus*. It was in the Neapolitan hills I saw a considerable amount of this formation.

In Victoria, the principal mass is on the Lawrence Islands, off Portland. The danger attending the visit, from the difficulty of landing, will not make it a popular resort for tourists. I found the base rock of very consolidated character. Part of it, consisting of ordinary tufa, and a dark coloured, marly-looking volcanic substance, ran to points one hundred feet and higher above the sea; and upon which, on different parts of the island, was the Cinder Conglomerate. While some of these *unrounded* cinders were minute in size, I noticed others a yard and more in diameter. A large piece of white felspar had somehow or other got wedged in the conglomerate.

A few years, comparatively, will see the last of this great curiosity of Victoria. The sea is constantly and successfully warring against so feeble and friable a material. When I was on the island, huge masses of the rock fell into the surging ocean. Gulche-ways pierce the fortress for the rushing tides, and resound with the scream of wild-fowl and the howling of the storm.

Having attempted an explanation of this formation some ten years ago, I may be excused, perhaps, an extract from that account, as I have not been able to repeat my visit:

“In the earthquake which tilted the Portland limestone westward of Cape Grant, it is not difficult to realize the action of a contiguous volcano. As no crater and no ashes are known inland, within fifty miles, it is highly probable that it was a submarine explosion. Some may imagine that it may have been that which occasioned the basaltic field, now recognized as Cape Grim, and the north-western islands of Tasmania; but from the prevailing westerly current, it may be presumed that the volcano was situated somewhere

south-west of the Portland Bay promontory. The period of its occurrence was a modern one, being subsequent to the limestone, our Tertiary stratum.

“It is certain that, from whatever cause originating, a considerable portion of the limestone upper crust was removed when lying beneath the water, as we found part of that space now filled with alternating sands and clay for fifty yards in depth, on the north-eastern side of Lawrence. Subsequently, then, to this deposition, itself so recent, was the submarine eruption of which we were speaking.

“As ashes rose from the vent and fell again into the waters, they would float on towards the limestone rocks, and in the waters of that shallow sea many of the pieces would gradually sink, and be mingled with the shifting sands. The absence of much abrasion would indicate comparatively quiet settlement. From the depth of stratum of the Conglomerate, it is probable that some little time elapsed during which fresh and continually occurring discharges from the submarine crater provided new material.

“There must have been some protection from the currents in the shape of projecting headlands, now washed away, else so frail a substance would have been swept away before consolidation. It is clear that no great time was allowed for the process, as we find no deposition upon the conglomerate. It is then in the highest degree probable that the whole coast line of the west rose almost immediately after such cinder subsiding; and it is equally probable that the last throes of all the volcanoes alluded to, were the agent of such elevation.”

#### LAVA.

Though tufa is the principal volcanic product of Rome, yet lava, in its various forms, proceeded from even the modern craters. One sees it there under romantic associations. The castellated tomb of Cœcilia Metella, wife of Crassus, seventy feet in diameter, was built outside the walls of Rome on the very extremity of a bed of lava from Mount Albano. Streams are here and there met with on the Campagna. Not far from the wonderful St. Paul's Church, beyond the walls, I saw the quarries of the street polygonal blocks, the uncomfortable pathways of the city. The huge masses of lava forming the highways of the ancient Romans, are in most cases buried beneath the accumulated rubbish of ages.

But though I could not refrain from emotion as I trod the Appian Way, furrowed by chariot-wheels, it is probable that the lava pavement, along which Paul was borne a prisoner, lay still beneath me; such being the opinion of some learned antiquarians.

Black lava issues through the red tufa of Lake Bracciano, while a porphyritic lava pierces the limestone of Mount Catimi. Great masses of lava fill the camp of Hannibal at Monte Cavo. There is some very ancient trachytic rock in Rome. The Albano lava I found to be as varied as the ash. Some specimens were dark, heavy, and of a basaltic character, while others were light and scoriaceous. There were pieces like our own brilliant stone of Leura, sparkling with gems.

I have not heard of basaltic columns nearer Rome than Mount Radicofani, on the borders of Tuscany. The Roman lava is not so rich in minerals as that of Naples. The ancient rocks of Monte Somma are said to have a variety of above forty minerals. The lava shares with travertine and tufa the honor of erecting the glorious monuments of old Rome.

In Victoria, to the westward, the lavas are very varied in sort. The party-coloured, bright bunches of crystals, in the augitic lava, give Mount Leura the palm for beauty. The effect is very striking, with the setting sun illuminating the thin, lofty wall of the crater. I gathered blocks from the Green Hill of Ararat, having all the look of those from the Solfatara of Italy; while the green lava of Wickliffe is rare in Rome. Plain basalt forms the floor of our Western Plains, though scoria is the principal rock of our extinct craters. The decomposition of this rock may vary more from constituents than age. Some hills preserve their vitrified appearance, with sharply defined edges, while others lose their outline in the red earth of decay. The sea wall, near Portland, is so decomposed by the weather that it assumes the character of variegated clays, except the shot-like protuberances remaining from the amygdaloidal basalt. Some of our lavas, as the more consolidated basalts near Melbourne and Ballarat, and on the plains, are probably of submarine origin; while others, especially towards the south-western part of the colony, are clearly subaerial. We have here, as in Rome, limestone nodules mixing with our lavas. Such are seen at Mount Gellibrand, west of Geelong, as well as at Mount Gambier. Trachyte is at Wangoon,

Tower Hill, &c., as well as Obsidian, the volcanic glass. Phonolite is plentifully distributed.

Western Victoria presents more basalt than Rome, and we have many examples of prismatic or columnar basalt. At our Wannan Falls, 160 feet deep and 100 wide, the prisms behind the water, in their broken aspects, are like the shifting glasses of a kaleidoscope. The columnar reaches thirty feet upon ten feet of amorphous basalt at the Hopkins Falls. In measuring some of the rhomboids there, I found them ten inches by six. Reference need not be made to the picturesque Falls of Lal-Lal, the Coliban, &c. The depth of our deposits varies greatly. Near Belfast I was shown a spot where the basalt was forty-eight feet thick, while alongside, on a little flat, it was four feet.

Though unable to trace the sources of all of our basaltic streams, some may be distinctly indicated. The Wannan outburst ran out at the Smoky River, forty miles north-west of Portland. From the Anakies, two streams descended to the sea. The courses from Mounts Eccles, Napier, Rouse, and Clay, are well defined, and were very considerable in volume. The lava from Napier flowed fifty miles southward, and nearly parallel to the lines of Rouse and Eccles. There is very little lava about Mount Gambier. It is curious to find Mr. Surveyor Tyers referring to our basaltic plains, in 1838, after this manner:—"The nearer the coast they are considered more fertile. The extreme fertility of basaltic soils, according to geologists, is to be attributed to the carbonized materials produced during the igneous fusion of the rock."

There are, however, some points of dissimilarity between the two countries. There is nothing in Rome like our Mount Porndon, toward the Cape Otway country, which struck me as simply a pumice cone. When I ascended Mount Vesuvius, and only then, did I see its parallel. But there is another peculiarity in the country around Porndon—the STONY RISES. These petrified waves of lava I saw near the Darlot's Creek, Portland Bay, as well as near Lake Corangamite, and even, to a small extent, by Mount Fyans. These singular phenomena much astonished me. At Mount Porndon there were vast basaltic caverns, with chambers of immense extent. Under Mount Eccles and Mount Napier the ridges are like the Bay of Biscay surges, tumbling in all directions. In the Stony Rises, south of Corangamite, toward the Curdies River, a district fifteen miles by twelve,

I found the rock as *barriers*; being walls running hither and thither, from ten to forty feet in height. The early settlers had great difficulty getting their flocks through these basaltic defiles. They are truly like the Devil's Turnpike of Mexico.

Our lavas are not of equal age. Mount Franklin gives an interesting illustration. One stream can be traced from that crater, covering up the ordinary auriferous deposits, and furnishing the bluestone capping of hills, under which the Jim Crow miners tunnel. A breaking up of the golden deposit caused a fresh distribution in some of the neighbouring gullies: and over this newer stratum of gold a second, and therefore newer, stratum of lava has flowed. As has been before stated, a discharge of lava from Mount Noorat covers the ash from Lake Keilambete. At the Moonee Ponds some basalt is considerably younger, and of a different character, than that upon which it rests. At Portland, or rather the sea cliffs southward, I saw two lavas alternating with beds of Tertiary limestone. I gathered oyster shells, of size and sort different from any on our coast, beneath a huge pillar of prismatic basalt, while beneath me lay the Eocene limestone.

We might indulge our imagination as to the physical changes produced by volcanic actions in our western country.

There is a great sea with granite islets. A column of smoke arises from amidst the heavy billows. Rumbling noises are heard. Flames, like water sprites, leap up from the ocean. The crash of thunders and the flash of lightnings proceed from near the spot. Writhing forms of convulsed matter agitate the waters. There is a seething caldron beneath. Masses of viscid substance gurgle upwards, and fill the caves of the dark sea. A change follows. The convulsions cease. The blackened, rugged walls of the submarine crater are still and cold. The sea has brought shot-like pebbles and white mud to spread over the bottom.\* The land rises, and shakes off its liquid garment. The granite islets are the mountains of Erildoun, Emu, and Cole, and the scene of volcanic fury is the grassy plain of Western Victoria.

## CRATERS.

As I have already mentioned, we cannot trace the ash-beds of Rome to their craterform sources, as we can in Victoria. They may be beneath the bed of the Mediterranean, as the Bay of Naples now covers the stirring caldron from which Naples obtained its ash. One must go about fifteen miles to get a view of a Roman extinct crater. At Lake Albano we find ourselves in the midst of the Fields of Fire. An amphitheatre of hills spreads out before the eye to the north, north-east, and north-west. Monte Cavo, with its snowy cap, is half a dozen miles from Albano. Pila is of the same range. Priora, Campatri, and Porzio, belched out their fires more to the northward.

One of the distant craters is Lake Bolsena, sixty miles north-west of Rome, and twenty-six miles in circumference. Mount Cimini, over Viterbo, was on the boundary between Etruria and Rome, and long sheltered the brave Etruscans in its forests and ravines from the grasp of Rome. Lake Vico, near it, is supposed to have engulfed an Etrurian city. Lake Bracciano, the ancient Sabatinus, is twenty-five miles west of Rome, and twenty miles round. By it is a hollow plain, Baccano, once on a crater, ten miles round, and a source of ashes, which has even now a sulphurous pool in its centre. I looked over a similar volcanic hollow, called Val-lariccia, near Albano, which Strabo said was formerly filled with water. Lake Nemi, a gem near Lake Albano, is nearly a mile across, and quite an oval crater.

Lake Albano was the particular object of my attention and observation. One of the Roman railways, *supposed* to go to Albano, landed me and the four other passengers by that train at a lone house on the wide and dreary Campagna, some two miles from the city. Reaching, at last, that town of poverty, uncleanness, and idleness, I hastened by the Etruscan monument, raised to the son of Porsenna, and, untormented by guides, mounted 1450 feet above the sea, near to the Castel Gondolfo, the charming summer palace of the Pope, and looked down upon the gently rippling waters of Lake Albano. There I found groves of the oak, ilex, chesnut and stone pine, in their native homes, unsupplanted by the olive and the vine. On the inside of the slopes of the crater a very luxuriant vegetation impeded my way. The lake lay hundreds of feet below, two miles and a quarter long, by one and a quarter broad. An emissarium, con-

structed 2250 years ago, drains the overplus of water to the Tiber. Who that gazed upon that charming scene, gaily set off in autumnal tints, could realise the wild tempest of horrors which once raged there !

The Bank of Albano put me more in mind of our own Tower Hill than any other place. Both are gardens of delight. Both have seams of lava and lime in their tufaceous beds. There were the little caves answering to our wombat holes. There the jet black basalt pierced the ash-heap, as I had seen in our craterform lakes. There was the white-spotted mineral, so conspicuous in the bold Mount Clay of Portland. The bank was even higher than ours of Tower Hill, though not so long. The sides were not so precipitous as those of Mount Gambier, down which I dared not venture ; nor did the water look so dark as that of the Devil's Inkstand. Lake Keilambete has walls as long and as oval, but not so elevated, as Lake Albano. One of the basins, not far from Timboon, has a great resemblance to the Roman one. Elingamite, in our southern stony desert, has few points of resemblance but its tufa sides. It put me more in mind of Mount Schanck in its basin appearance ; though that Devil's Punchbowl, naked outside, is covered with fern on its inner and precipitous slopes.

The Albano water is fresh and deep. We, in Victoria, are favoured with fresh and salt water craters. Purrumbete, south of Colac, has delicious water. I listened to the splash of oars in that secluded region, and saw a fair lady rowing a pretty aboriginal child. Keilambete is quite salt, though I tasted of a fresh stream which gurgles out near the edge of the other water. The lake is two hundred feet deep. Bullen Merri, three hundred feet deep, is fresh, while its saline neighbour, Gnotuk, at a few yards distance, does not reach its level of surface by fifty feet. Lake Keilambete knows only a difference of eighteen inches between its winter and summer level ; and lakes Terang and Wangoon, with fresh water, have little more. The depth of fresh water Lake Power, formerly known as the Devil's Inkstand, is two hundred and sixty feet, and is not, as was once supposed, unfathomable. The oldest inhabitant believed there was no bottom in our Lake Wangoon, near Warrnambool, until some one tried its bottom with a line.

Most of our Victorian craters which discharged ashes are converted into lakes, while those that discharged basaltic lavas are dry. The South Australian Schanck, although of ash,

contains no water. No high range is near, and the whole country around is of cavernous limestone, with its subterranean streams. Mount Elephant crater, rising nearly seven hundred feet above the plain, has occasionally water. I was struck with the luxuriant verdure there contrasted with the parched-up grass of the country around it.

Two of our craters resemble the Monte Cavo hollow, in which Hannibal had his camp. Our Mount Noorat is three miles across its shaggy basin, though scoria cones rise up within the crater, and a huge blister-like rock nearly blocks up the side through which the lava poured. It is 250 feet deep, and Leura 300; though the latter has been so shattered as to have but a thin shred of a wall remaining. The Roman craters were mostly broken down on the side exposed to Rome, having given that quarter the benefit of their discharge. Leura is fallen on the west side, Wangoon on the west, Napier on the south-west, Purrumbete and Noorat on the south and south-west. Mount Shadwell, which has, like Albano, discharged both ash and lava, has lost half its wall, and its reddened sides exhibit considerable oxidization, affording splendid soil for the farmer.

Napier, though one of our loftiest craters, 1440 feet, is but half the height of Monte Cavo, though just the elevation of Albano. Its crater discharged lava, which about there towers in fantastic forms. Its narrow ledge is gained with difficulty, and is not, like Cavo, adorned with ruins of an ancient temple; though within its drear basin the natives were wont to hold their most solemn moonlight corrobories. Superstition has her tales of the craters of Victoria as well as Italy, though priests have not sacrificed within their gloomy recesses.

Though not dignified as craters, there are several Roman hills of a scoriaceous or tufaceous character, which are rounded and closed at the top, but which may be more than suspected of disturbance in olden times. Such too are our numerous Mammeloidal hills to the west and north-west of Ballarat. Some, like Mount Cavern, have a portion of the top open, sufficient to indicate their former mischievous propensities. While a few exhibit a tendency to the crater of elevation, or blistering up from below, others show a collapsing after their explosion, as though glad to conceal the ghastly chasm from which such devastation issued. They are all, as far as I have observed, much older than the regular extinct craters, judging from the decomposed con-

dition of their framework, and the quantity of soil around their base.

#### AGE.

A year before I entered Rome a good and learned Irish priest had made a notable discovery there. His duties were at the San Clemente's Church, an edifice eight hundred years old, which you enter by descending steps. He had the good fortune to discover that this rested upon a much more ancient church of St. Clement, erected in the Imperial times. Further investigation led to the announcement that this primitive Christian house of prayer was raised upon a heathen fane, of vast proportions, whose walls stand there with blocks of volcanic Peperino eighteen feet in length. This is a story of Time.

Entering, then, upon the Age of the Volcanic Fields of Rome and Victoria, we must have recourse to some such process of descent as with that of San Clemente. We must go down to the Past.

We have more data for estimating the age of the volcanic monuments of Rome than of Victoria. Human appreciation of time is always insignificant. While standing beside the towering Coliseum, or keeping pace with the ghostly tread of legions on the Appian Way, the awe of distant years came over me. But long before Eternal Rome began her wondrous life, the fires that raised the soil were quenched, and herbs and flowers had healed the wounds of strife. It was fitting that the city which set the world in flames should rest upon flaming fields.

A few minutes before the iron horse carries the traveller along the tufa plains into Rome, a low range of hills may be seen. A railway cutting exposed a part of the diluvial base, and brought to our view some of the original inhabitants of the country. Bones of the elephant, hippopotamus, and rhinoceros, rolled out of the post Tertiary marls and sand. The blue-clay pits tell the same tale at the rear of the Papal Palace. The red Tufa Lithoide is near this formation. Over the tufa, and forming the summit of Monte Mario, are the Tertiary Mosaic beds of the Pliocene order, containing three hundred species of shells. Upon the celebrated Pincian Hill the remains of elephants have been discovered *under* a bed of travertin. Forty feet of fresh-water deposits lie on the summit of the hills. We have evidence of the existence of fresh-water lakes between

the hills ; and the prodigious sewer, the Cloaca Maxima, is conjectured to have been constructed as a sort of emissarium to drain the last of the city waters.

The history of Travertin may help us in the question of time. At Tivoli the foaming falls and sparkling cascata wear down the thick beds of travertin which repose upon the tufa. This rock was formed in an ancient lake, which may probably have been one of the craterform sources of the earlier ashes, but which became converted into a lake upon the elevation of the land after the eruption. Ages must have passed for soil of such quantity to be produced as to make the sweet valley of the Anio so tempting to those Greek adventurers, who sang their Attic songs at Tivoli before a Roman hut appeared.

When I saw both tufa and travertin united in the walls of the Temple of Vesta, which looked over the laughing waters at the Villa of Horace, I learned the alliance of earth and intellect, and felt that one purpose of Deity in raining showers of fire, and growing limestone hills, may have been that man might rear new forms of beauty, and transmit sentiments of elevated pleasure through those lithic works of thought.

The history of the volcanic process in Rome and its immediate neighbourhood may perhaps be thus described. Basaltic currents ran in very early times. Subsequently, tufa lithoide fell upon the earth, or mingled with the shells of the ocean. A subsidence followed ; and during the tranquil ages the Mosaic Tertiary beds were formed. A fresh convulsion disturbed this serenity, and threw up hills which yet retain their capping of the ancient deposits, while all around was denuded by tumultuous waters. The sea now receded, and then came water formations of varyingly aged travertin, or sediment brought down by rivers. A highway may have existed from Africa to Europe, and the elephant, hippopotamus, and rhinoceros, may have travelled beside huge rivers that fell from Alps now lost in the Equatorial Atlantic. Carcasses of these monsters were carried down by flooded creeks, and buried with the diluvium in the waters of Rome. The travertin stole quietly in when the ancient rivers were turned, and the Roman lakes were undisturbed by eddying streams. More tufa and lava followed. Another change lowered the level of the country, much of the diluvial deposit containing the elephants was washed away, and there was a renewal of the sedimentary process at the

bottom of these fresh-waters. The Sabine hills now burst forth with tremendous energy—earthquakes raised the Seven Hills of Rome, with their masses of volcanic rock, travertin, and elephantine beds—and then the vast accumulations of descending ashes, the present tufa granolare, were washed by heavy rains in all the vales around, and walled in the very Mediterranean. Again came repose. The Tiber, rolling from the Appenines to this sterile land of desolation, pierced its tufa beds, and carried the debris to the sea. The ash itself yielded to the softening influences of nature, and prepared for the granaries of Imperial Rome.

In discussing the age of our Victorian volcanic deposits, especially those tufaceous ones which are so similar to the Roman beds, I fear I can say but little, and that without the poetry and romance so associated with Italian geology. We live in a prosaic part of the world, unvisited yet by gentle fairies, or by rambling ghosts. But if no Horace has farmed our tufa, no Nero has tortured in our tufaceous caverns. Though our ancient songs have been but the chants of lubras at corrobories, our lava plains have not been bathed with tears and blood as the fair Campagna.

The fossil marsupial lion, found in connection with our ash-beds to the westward, most certainly takes us far back into the past. It is a long day since the kangaroo and wombat, whose gigantic size and curious formation so astonished the English geologists, were laid by Lake Colangulac, or washed into the Wellington caves of New South Wales, where Major Mitchell found them thirty years ago beneath the red earth. We have no Carnivora now of any species, allied with a monster that played such havoc in the old Victorian forests among the gentle kangaroos, four yards in height. Yet these were the creatures inconvenienced by our descending ash showers. I found the tooth of a primitive shark in a deposit at the edge of the superimposed tufa.

Our oldest inhabitant has lived here but thirty years. In Italy there are records of nearly as many centuries. We may, therefore, with grace yield the palm of superior antiquity of volcanic action to our mistress on the Tiber, though our tufa is as thick as the ash of the Catacombs, and our bluestone as hard as the blocks of the Appian Way.

As to our basalt—that successive streams flowed over the same spot is a fact well known to our enterprising diggers, who pierce four such strata at Ballarat. Such are found,

however, to be very similar in mineral character, with no great apparent pauses between the eruptions, which came doubtless from the same centre.

If, as most think, our alluvial diggings are of recent Tertiary times, the superimposed basalt may be more modern than many others. Yet even there has been time for soil for a forest clothing. I have elsewhere alluded to the deep masses of calcareous rock between two beds of Portland basalt. The existence of hundreds of feet of rock, consisting chiefly of the debris of a coralline sea, would assume considerable antiquity for the first basalt.

In New South Wales the basalt is very common in the coal-fields. Count Strzelceki gives four distinct epochs for the Tasmanian basalts. When standing by the celebrated opalized tree, near the Derwent, I observed that deep beds of basalt lay upon a broad sheet of greenstone. If Victoria differs from Tasmania in its rich deposits of ash, it is inferior to the island beauty in the relative extent and variety of its more consolidated volcanic products.

In conclusion, if we have no *past* glories of greatness, like Rome, to associate with our Victorian volcanic rocks, let us build up with them a bright and happy *future*. A numerous and gladdened peasantry may till our tufa fields. Works of material progress, structures of architectural beauty, haunts of science and the arts, schools of learning, fanes of piety, and homes of free and virtuous citizens, may stand before our children, and our children's children, in the everlasting basalt of our rocks—a type of that stability of being found in truth, in peace, in love.

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ART. V.—*Experiments and Observations on Absorption.*

By GEORGE B. HALFORD, M.D., Professor of Anatomy, Physiology, and Pathology, University of Melbourne.

[Read 11th June, 1866.]

I purpose to lay before the Society the results of some experiments upon the absorption of colouring matters by the living body. It is well known that absorption takes place readily when fluids are thrown into the loose connective tissue beneath the skin, or into the serous cavities, as also from the great mucous tracts extending from the eyelids to the lungs, and from the ears to the anus. From the skin also,